Advanced Spacecraft Technologies to Explore the Ocean Worlds for the Detection of Extant Life

Completed Technology Project (2016 - 2018)

Project Introduction

Brief description of the goals and objectives of the proposal The surfaces of the Icy moons—Europa and Enceladus—are mostly composed of ice. Several ocean worlds are widely believed to harbor sub-surface oceans and the potential for habitable environments, which makes these ocean worlds (icy moons) of prime interest in the search for life beyond Earth. Therefore, mobility technologies that enable robotic in situ exploration of the surfaces of icy moons are of high interest for NASA's future missions. However, no current state-of-the-art (SOA) mobility system can operate in the rugged terrains of the ocean worlds. A team of investigators at Purdue University and Thin Red Line Aerospace proposes a low-cost effort to develop and test an innovative and game-changing mobility concept for the exploration of surfaces of the ocean worlds—Europa and Enceladus. The proposed rover is at TRL 2. The effort will draw from prior work on JPL's Mars rover design and optimize for ocean worlds' extreme environments and rugged, jagged terrain types. The proposed rover overcomes the drawbacks of NASA's Mars rover design by incorporating longer and adjustable platform wheelbase large diameter tires which are puncture-proof, expandable, wide, and conformal tread that provides excellent traction on rugged terrains while offering outstanding wear resistance. Both the rover chassis frame and wheels are capable of compact stowage and simplistic lightweight construction to accommodate efficient packaging with the lander to create a high elevation mobility exploration platform. The goal of the proposed effort is to demonstrate the proof-of-concept in an analog environment and technical risk reduction, thus pushing to TRL 3 at the end of the Concepts for Ocean Worlds Life Detection Technology (COLDTech) effort. The resulting enabling technology may finally be proposed in response to future Announcements of Opportunity (AOs) for flight missions in the next decades. The proposed mobility system is game-changing and is an "enabling" technology for an ocean world mission, not possible with a current state-of-the-art system. The proposed system offers substantial benefits and "enables" the surface exploration the ocean worlds. Brief description of the methodology to be used to address them We propose a rigorous and meticulous technology development plan which includes detailed analysis, simulation, design, prototyping of a scaled model, followed by evaluation and testing in analog conditions. The technical approach is divided into five distinct activities: (A) Rover system design and mobility dynamics (B) Rover tire and wheel development (C) Rover chassis mechanical design (D) Prototype fabrication, and (E) Evaluation and testing. Relevance of the proposed research to this call The proposed technology is relevant to a potential mission to one of the ocean worlds—Europa and Enceladus— for the detection of extant life and habitability at multiple sites of scientific interest. A rover with mobility capabilities like the one proposed can expand the data collection of a potential Europa landed mission by accessing multiple sites. A mobility platform could potentially approach the vicinity of an active geyser for collection of subsurface materials. No current state-of-the-art mobility system can operate in the rugged terrains of the ocean worlds, Europa ad Enceladus.

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Responsible Program:

Concepts for Ocean Worlds Life Detection Technology

Advanced Spacecraft Technologies to Explore the Ocean Worlds for the Detection of Extant Life

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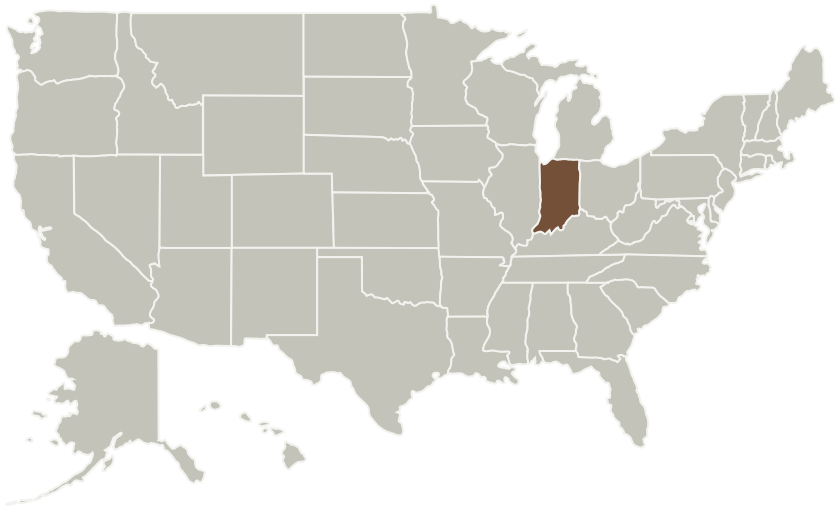
The goal of the proposed study is concept development and technical risk reduction for potential future missions so that they may finally be proposed in response to future Announcements of Opportunity (AOs) for flight missions in the next decades. The rover will enable answers to important planetary science questions and goals in the NASA Science Plan, and therefore are relevant to NASA.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Purdue University-Main Campus	Supporting Organization	Academia	West Lafayette, Indiana

Primary U.S. Work Locations
Indiana

Project Management

Program Director:
Carolyn R Mercer

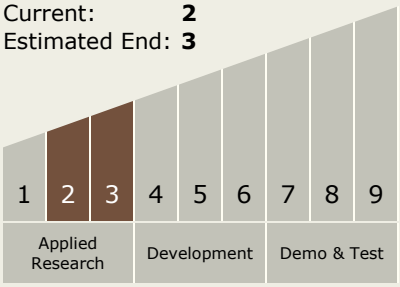
Program Manager:
Carolyn R Mercer

Principal Investigator:
James Longuski

Co-Investigators:
Maxim L De Jong
Michael R Ludwig

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX04 Robotic Systems
  - TX04.2 Mobility
    - TX04.2.4 Surface Mobility

Target Destination

Others Inside the Solar System